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Raman study of optical vibrations in InAs/GaAs self-assembled quantum dots

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The optical vibrational modes were studied in the strained InAs/GaAs heterostructures containing self-assembled quantum dots. The both, optical phonons in the InAs dots and in the GaAs barrier were detected by the resonance Raman scattering at the $E_0 + D_0$ gaps of InAs and GaAs correspondingly.

The LO and TO phonons in the InAs dots revealed strong shifts due to the strain. The observed strain induced frequency shifts were found in good agreement with the values calculated for the pyramidal InAs dots embedded in GaAs [1].

A number of Raman lines were observed in the frequency range of the GaAs optical phonons; the intensities of these lines significantly increased with increase of the density of the InAs dots measured by atomic force microscope. The theoretical analysis based on the calculation of the energy spectrum of the interface modes localised at sharp tips [2] and on the strain calculated for the pyramidal InAs/GaAs dots showed that the observed modes can be assigned to the GaAs-like interface modes localised at the apexes of the InAs pyramids, which are subjected to the strain. The Raman scattering measured with different excitation energies revealed the dispersion of these interface modes caused by both the spatial distribution of the strain in the InAs/GaAs heterostructure and the spatial dependence of the electrostatic potential of the interface modes.

References

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